Telecommunications Architectural Standards

Building Pathways and Spaces
Building Wiring
Infrastructure Administration
in Washington State Government

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Adopted by:
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Telecommunications Architectural Standards
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Policy

Adopting Telecommunications Architectural Standards for Building Pathways and Spaces, Building Wiring and Media Administration

Statutory Authority

RCW 43.105.017(4)(a) states that the legislature intends through the establishment of the Department of Information Services (DIS) that "a structure be created ...to plan and manage telecommunications and computing networks..." RCW 43.105.041(3) empowers the Information Services Board (ISB) "to develop state-wide or interagency technical policies, standards, and procedures..."

Purpose

To satisfy the statutory mandate, a comprehensive set of architectural standards for telecommunications, data and computing is under development. The first three components of the telecommunications architecture accompany this policy. They address 1) the physical spaces and pathways that house communications equipment and wiring within state buildings; 2) the media itself: wire and cable; and 3) the administrative practices for keeping records on pathways, spaces and wiring.

Objective

To promote uniform design, installation and management of telecommunications pathways, spaces and wiring in state facilities to achieve resource economies in the use and movement of media.

Applicability

The standards apply to general office space in buildings owned or leased by the state with usable floor space of 10,000 square feet or more. They do not apply to such special purpose facilities and institutions as prisons, hospitals, classrooms and garages.

The space and pathway standards apply to new state owned construction and newly leased office space with a term of ten years or more; portions apply to renovations and remodels. The media standards apply to new state owned construction, newly leased office space with a term or five years or more, and space that undergoes total renovation or complete remodeling. The media administration standards apply to new state owned construction, all newly leased office space, and major telecommunications rewiring projects.

Effective Date

Because of the budget consequence of the standards, full compliance will not be required until the 1993-95 biennium. Until that time, the standards will have the status of optional guidelines. Agencies are encouraged to adopt the guidelines as soon as practical.

Policy Statement

State agencies shall comply with the minimum standards for building pathways and spaces, building wiring and infrastructure administration; unique applications shall be accommodated by the design and construction or installation of additional space and media above the minimum requirements.

Exception Process

Significant departures from the standards require Planning and Policy Division approval.

Maintenance Standards
Technological advances and changes in agencies' business of the requirements will necessitate periodic revisions to the standards adopted under this policy. The Planning and Policy Division of DIS is responsible for routine maintenance of the standards to keep them current; only major policy shifts require ISB approval.

Introduction

The Telecommunications Architecture is a collection of standards, recommendations, guidelines, and procedures to help government organizations manage telecommunications resources. The first three pieces of the Architecture deal with the telecommunications infrastructure: the pathways and spaces necessary for telecommunications cable and equipment, the building wiring itself, and the administration of this infrastructure.

- The standards apply to new construction or renovation of office space of 10,000 square feet or greater. They require no retrofit of existing state office facilities.

- The standards are designed to encourage flexible building space and wiring systems that meet most state government telecommunications needs, supporting the delivery of data, voice, and image today and in the future.

- To design, construct, and wire a building for telecommunications systems, telecommunications facilities should be incorporated during the preliminary architectural design.

- The importance of infrastructure administration cannot be overstated. Management of building wiring and pathways is the key to avoiding continuing "cable chaos."

- This document specifies minimum standards. Application requirements may dictate installation of additional media.

Business Case

The business case for space and pathway standards is related to the business cases for building wiring and media administration. Washington state agency experience with non-standard space and pathways indicates that a set of standards will reduce overall costs and enhance productivity. Some examples are outlined below.

- When the Washington State Patrol moved forty employees into a leased facility, it determined that the telecommunications closet was too small to house the required equipment. The State Patrol spent $12,000 on materials and outside labor to rewire the facility. In addition, hundreds of internal labor hours were required.

- The Department of Transportation's headquarters building uses an under-floor duct system. The inflexibility and limited capacity of this approach has prevented moves because of the high cost of cable relocation.

- The Washington Community College Computing Consortium provides service to facilities with telecommunications closets less than two feet deep. This precludes the installation of needed communication equipment in the telecommunications closet. Other buildings without adequate cable pathways result in a combination of expensive core drilling and exposed wiring on wall surfaces. This solution lacks aesthetic appeal. It invites accidental damage and intentional tampering.

- At the Department of Labor and Industries the lack of adequate building pathways causes several problems. Lengthy analysis (hours vs. minutes) is needed to determine how to accomplish a simple user move. Arranging user access to an application can require forty to sixty hours effort. Outage risks are much greater during moves and changes due to the complexity of the wiring and cabling changes.

The horizontal access standards include access floors and ceiling distribution systems. Lack of comparable flexibility and higher life cycle costs eliminate the underfloor duct (cellular floor) systems. The choice of raised floor or ceiling distribution involves numerous factors which may vary from building to building (Appendix D). Consequently, it is not feasible to mandate a single standard.

Cost is a major consideration. Recent comparisons were made for the Natural Resources and Labor and Industries buildings. General Administration experience and contacts with architects and suppliers of horizontal distribution systems resulted in the following figures:

	Initial Cost Per Sq. Ft.	Cost Per Move Per Employee
Access Floor	$7-10	$80
Ceiling Distribution	$4-5	$200
Underfloor Duct	$5-7	$250

These cost figures are consistent with general industry experience. The trend to access floor in office building design is growing; more than 50% of contemporary office design incorporates access floor.

Background

Historically, building wiring systems were designed to provide for telephone, power, and control functions. In recent years, significant changes have occurred in the wiring requirements for state offices. These changes have been caused by three separate and nearly simultaneous events:

- The deregulation of telecommunications equipment and wiring. For most of the twentieth century, telecommunications services were provided by a monopoly public utility. Today, the local telephone company no longer manages building wiring or the consumer's telecommunications equipment.

- Tremendous growth in the need to network small computers. The rapid proliferation of personal computers has introduced a new layer of complexity to the building wiring environment. Today's peer networks link large user populations and transmit huge volumes of information.

- An increasing dependence on telecommunications technologies to accomplish the missions of state government. Technologies such as digital telephones, voice processing, local area networks, video, and electronic document distribution strain the telecommunications infrastructure and require frequent recabling.

Infrastructure

The building infrastructure for telecommunications consists of two primary components: spaces and pathways for equipment and cable, and building wiring for distribution of information throughout the building. The dynamics of telecommunications technology and the changing needs of users require an adaptable infrastructure.

Design of the space and pathways for telecommunications wiring and equipment has long term consequences for a building's inhabitants. Carefully planned spaces and pathways allow the cost effective change of equipment and building wiring over the life of the building. Flexible design significantly reduces the day-to-day cost of telecommunications operations.

Building occupants often move within and between buildings; their needs change, and space change is the result. Telecommunications is a building utility, the information utility responsible for the reliable delivery of information throughout the building. The telecommunications infrastructure requires essentially the same design strategy as other utilities: a static core and area distribution points. It also has security, maintenance, and operational components.

Planning for a building's telecommunications system includes telephone, data, and other types of telecommunications systems, such as: video, security, paging and building control systems. Shared use of the telecommunications infrastructure may improve its cost performance. Completion of open protocol standards for the building controls industry, as well as standards for desktop video, may encourage infrastructure resource sharing.

Building Wiring Standards

Today, nearly every state office contains some telecommunications wiring. State workers do everything from moving modular telephone plugs between outlets to buying and installing cables for local area networks of personal computers. With no state wiring standards, much of this activity is less than productive. In less than five years, one leased space in Olympia has been occupied by three agencies, and rewired three times. Non-standard wiring and failure to track and document installed cable account for such examples of duplication and waste.

In 1985, the Computer Communications Industries Association asked the Electronics Industries Association (EIA) and the Telecommunications Industries Association (TIA) to develop uniform building wiring standards to support multi-product, multi-vendor telecommunications. A workgroup was established to develop standards for commercial buildings. The group's work will ultimately become an American National Standards Institute (ANSI) Standard.

The Commercial Building Wiring Standard is designed to allow the planning and installation of building wiring with little knowledge of the telecommunications products that subsequently will be installed. Installation of wiring systems during building construction or renovation is significantly less expensive and less disruptive than after building occupation.

The emerging national standard contains recommendations for: the media (wire) itself, the topology of the media, terminations, and administration. It recognizes that telephone, data and other communication systems and media are dynamic. Over the life of the building, both equipment and media will change dramatically.

This set of State standards is based on the draft national standards; excerpts appear in Appendix A.

Standards for Spaces and Pathways

During the development of the wiring standard the EIA realized that it wouldn't help to standardize the wire unless the building itself was constructed to handle telecommunications wiring. A separate effort was established, in 1987, to standardize buildings' architectural design to support telecommunications systems and media.

The building standard covers three principal areas of building design and construction: building areas that support telecommunications media and equipment, intrabuilding media pathways, and interbuilding media pathways.

Administration

If equipment never changed, and if state workers never moved from one location to another, there would be no need for wiring administration. State workers would stay in the same office and use the same telephones and data lines. But people do move, and equipment changes. Wiring administration has a major (and growing) financial impact on every telecommunications user and building owner.

A Motorola Corporation study estimates the cost of modifying installed cabling to support routine internal moves of people with networked computers at between $1000 and $1500 per move. With about half of Motorola's 80,000 employees using networked computers, the annual cost of routine internal moves approaches $10 million, and this study did not consider the cost of lost productivity during these moves. Washington State University reports that its cost of telecommunications moves, adds and changes equals one full-time equivalent per 50,000 square feet of office space per year.

Administration of existing building wiring is essential for the efficient movement, addition, and change of state employees and their communicating information technology equipment. Wiring administration keeps track of where cables go, what applications they support and how much spare capacity remains.

Directions

The state of Washington subscribes to the EIA standards as they apply to the design and installation of telecommunications systems for office environments. While the EIA standards outline many of the basic principles used in the design of telecommunications distribution and wiring systems, the Washington standards include specific requirements for new state office construction and major building renovations.
Generally, where the state standards conflict with the EIA standards, the state standards take precedence. This does not in any way relieve the designer or contractor from adherence to the EIA requirements in areas not explicitly covered by the state standards.

These standards do not preempt the requirements of the Uniform Building Code, applicable municipal building codes, the National Electrical Code, or Part 68 of the Rules of the Federal Communications Commission.

Types of Facilities and Applicability of these Media and Space Standards

The state of Washington standards for telecommunications media and space apply to new office space construction and some leased facilities. In certain cases these standards apply to major renovation projects. In small or modest remodels, application of the standards is optional.

The matrix on the next page summarizes the circumstances under which the standards must apply and those under which they may apply. The following is a key to the matrix:

Existing — Any changes or additions should continue use of the existing type of wiring, punch down blocks, outlets, telecommunications closets, etc.

Optional — If possible, as a function of cost and time, agencies should follow the standard when, for example, installing horizontal wiring or new outlets in the work areas.

Mandatory — Application of the standard is required, absent some very compelling business or technical reason.

Major Remodel — An entire floor or story of a building is being remodeled; changes include primarily cosmetic, as opposed to structural items.

Total Renovation An entire building is being renovated; changes are structural, such as movement of load-bearing walls.

Types of Facilities
and
Applicability of Media and Space Standards

	Minor Remodel	**Multi-Office Remodel**	**Major Remodel**	**Total Renovation**	**Leased Building (new)**	**State Building (new)**
Horizontal Pathway	Existing	Existing	Optional	Optional	Mandatory	Mandatory
Backbone Pathway	Existing	Existing	Existing	Optional	Mandatory	Mandatory
Telecom Room Space and Environmental	Existing	Existing	Mandatory	Mandatory	Mandatory	Mandatory
Equipment Room Space and Environmental	Existing	Existing	Optional	Mandatory	Mandatory	Mandatory
Entrance Facility	Existing	Existing	Existing	Optional	Mandatory	Mandatory
Horizontal Wiring	Existing	Optional	Mandatory	Mandatory	Mandatory	Mandatory
Backbone Wiring	Existing	Existing	Optional	Mandatory	Mandatory	Mandatory
Work Area Outlet	Existing	Optional	Mandatory	Mandatory	Mandatory	Mandatory
Telecom Closet Wiring/Cross Connects	Existing	Existing	Mandatory	Mandatory	Mandatory	Mandatory
Equipment Room Wiring	Existing	Existing	Optional	Mandatory	Mandatory	Mandatory

1. *Building Pathways and Spaces*

1.1 Horizontal Pathways

Horizontal pathways distribute building wiring to work areas, typically on one floor of a building (Figure 1). Work areas are the spaces in a building used to house employees and their information technology equipment. Because of the variety of pathway choices and the frequent changes likely to occur in these pathways, design of the horizontal facility is the most difficult aspect of telecommunications space and pathway design.

Information technology intensive work areas and high employee churn rates make flexibility the number one distribution system priority. The horizontal pathway standards facilitate relocation of employees and equipment at low cost and with minimal disruption, and provide the capacity to meet the wiring needs of the future.

Standards for Horizontal Pathways:

- Access floors for open office space
- Ceiling distribution systems
- Hallway cable trays

These standards assume one work area for each 80 square feet of usable floor space. This is smaller than the work area size assumed by the national standard. State offices are typically designed with 125 square feet for each employee, but 35% of this is common space.

The Commercial Building Wiring Standard specifies a maximum distance of 90 meters or 295 feet for the cable run from the local distribution room (telecommunications closet) to an information outlet in any work area. Horizontal pathway lengths shall be compatible with this distance limitation (Figure 2).

Horizontal pathways should be designed to avoid sources of electromagnetic interference, such as electrical power systems and lighting fixtures.

Access Floor Distribution

The standard for horizontal cable pathways in new construction of open office spaces with a high density of end-user telecommunications devices is the access floor (also called raised floor).

An access floor is raised above the existing subfloor and provides access to space under the floor panels. Studies show that the operational payback over the life of the building generally outweighs the high initial cost of these systems.

Access floors are not recommended for short-term leased office space (less than ten years). Figure 3 illustrates the life cycle costs for several horizontal pathway alternatives.

A raised floor provides easy access to all wiring, and allows the wiring to be adapted to the maximum number of arrangements for using the available floor space. With an access floor, workstation changes or new installations can be made quickly, inexpensively, and with little disruption of office routine.

An access floor consists of squares of die-cast aluminum plates. These plates rest on and lock into cast aluminum interlocking pedestals. Steel footings sit on the subfloor and support the plates. The square plates can be individually covered with tile or carpet. Rolled carpet should not be used to cover access floors. Structural improvements have eliminated the hollow echoing that once plagued these systems. Figure 4 shows a typical access floor layout.

A rigorous system for cable management preserves the utility and value of raised floors. Cable may be distributed according to a zone system. Typical zone systems divide the usable floor area into zones of 400 to 900 square feet. Bundles of horizontal distribution cable run from the telecommunications closet to the midpoint of each zone, and distribute to the work areas from that point. Cable trays, fittings, or clamps are used to manage the cables under the access floor.

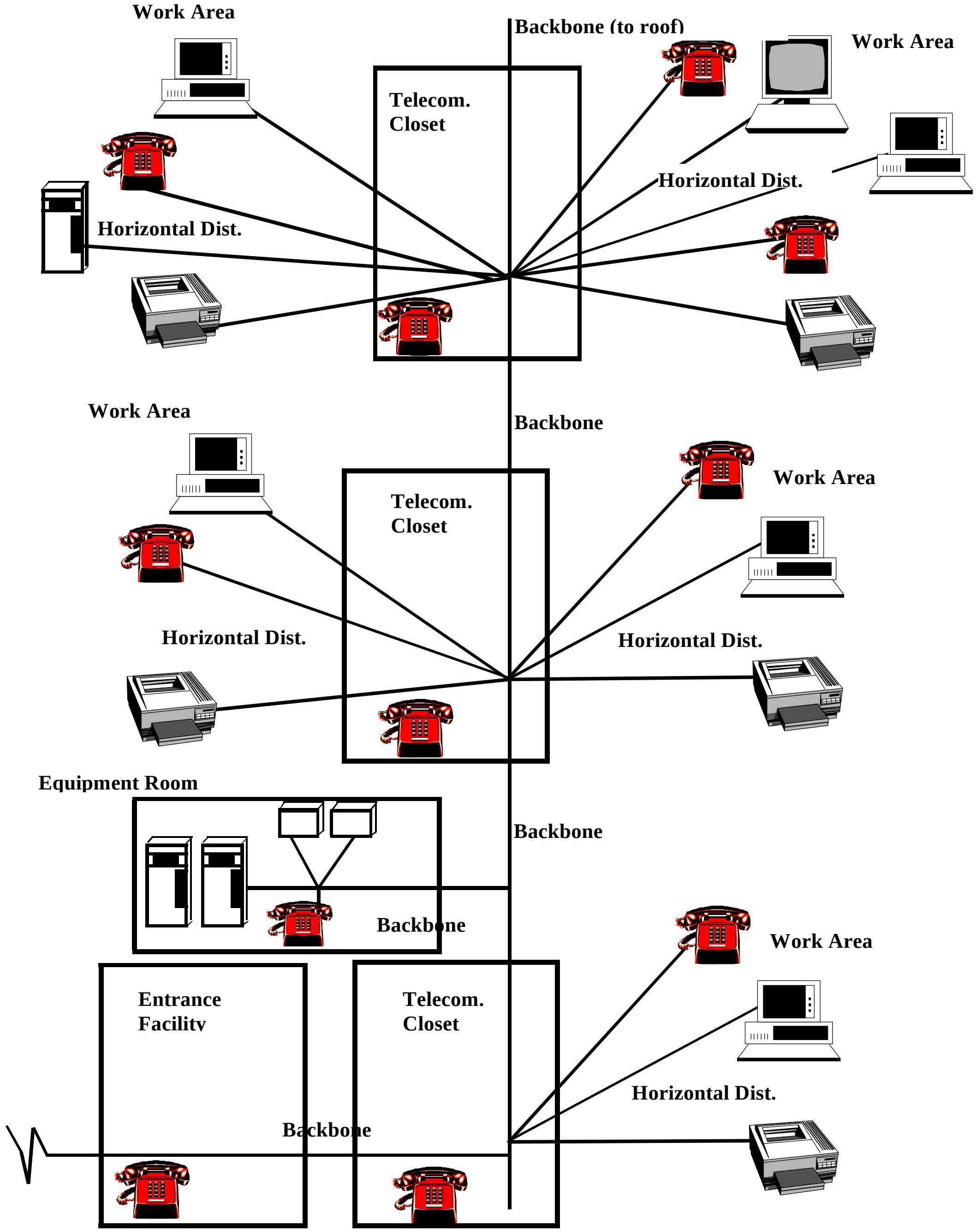
Air design should be synchronized with cable distribution design. Since underfloor air delivery systems are often used with access floors, they should complement each other.

Access floors should be raised a minimum of six inches for office space and 12 inches in equipment rooms. Building codes require seismic bracing of the floors. All metal parts of an access floor must be bonded to ground. The resistance between the bare top surface panels and the pedestals should be one ohm or less.

The enclosed space between the subfloor and the raised floor should provide space to accommodate wiring for present and future office technologies. Specifications for access floor pathways are included in section 4.3 of the Commercial Building Standard.

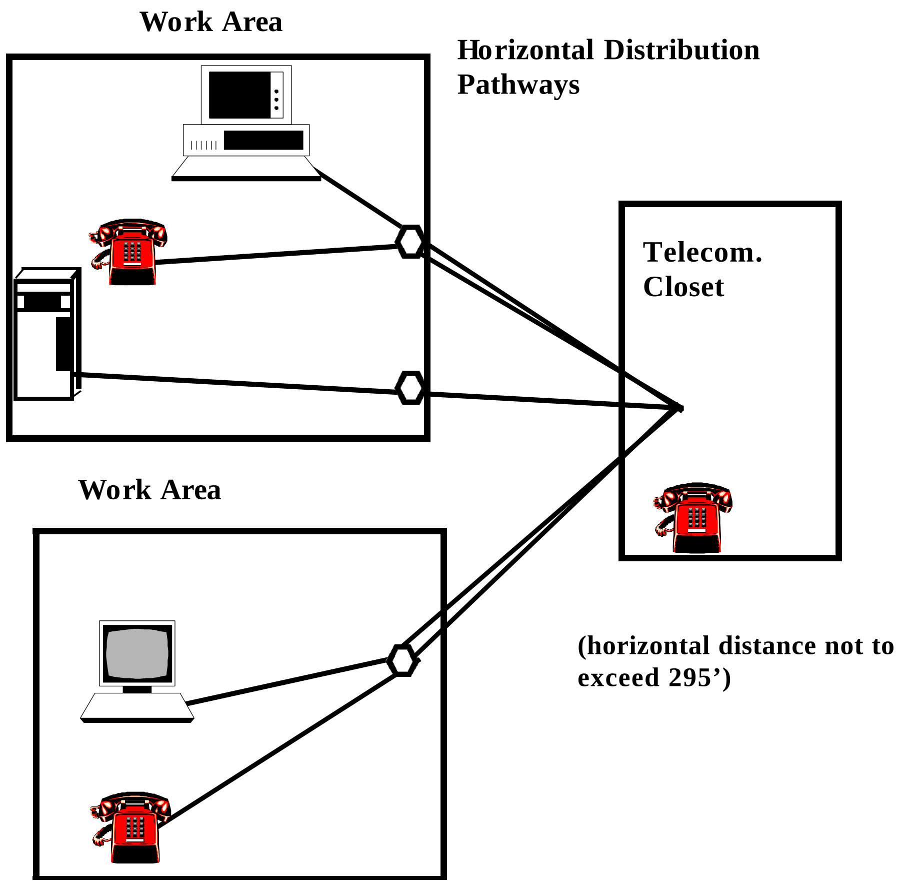
Distribution Pathways

Figure 1



Horizontal Distribution

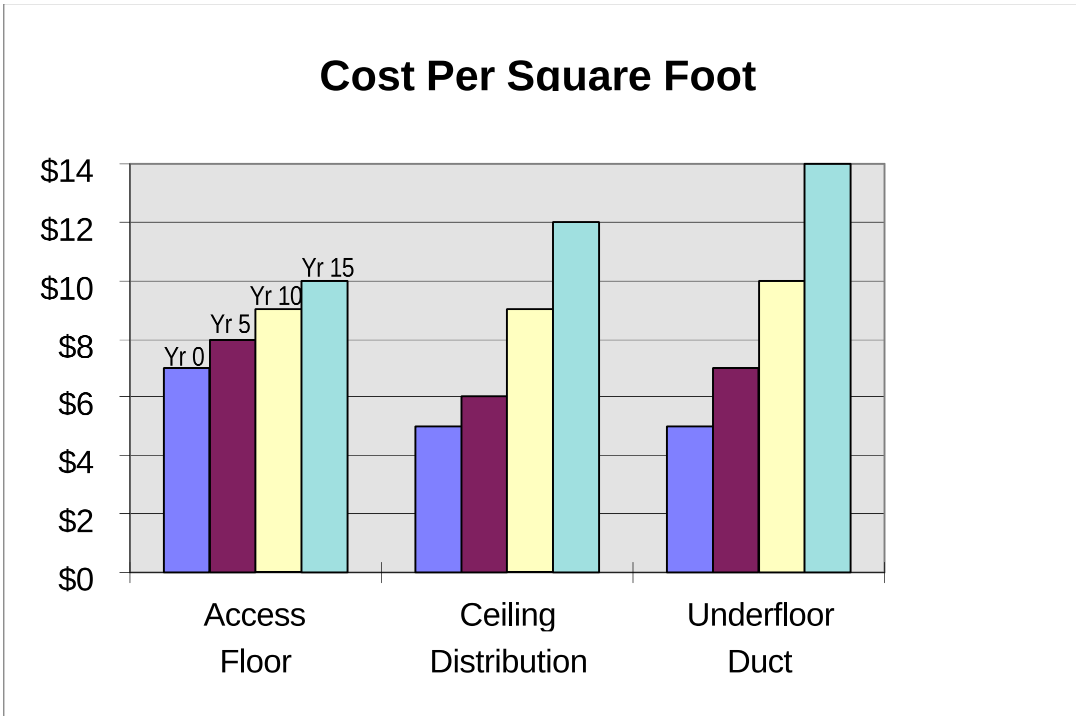
Figure 2



Horizontal Pathways

1990 Lifecycle Costs

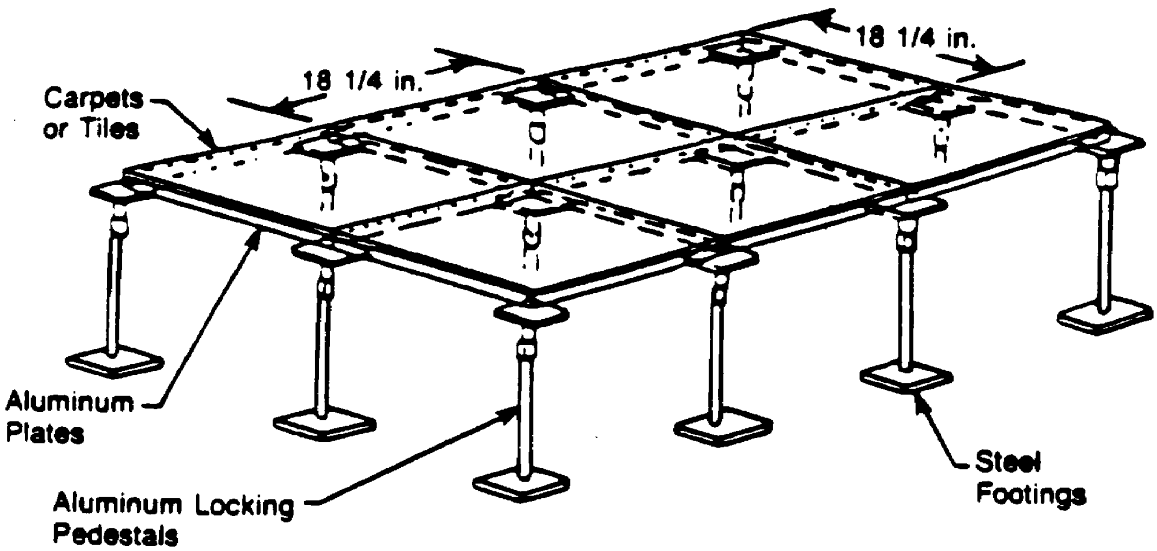
Figure 3



Churn rate: 20% per year
Inflation rate: 5% per year

Access Floor Pathway

Figure 4



Ceiling Distribution

The standards call for ceiling distribution systems for remodeled open office space that cannot accommodate access floor systems. Ceiling distribution pathways should only be considered when removable ceiling tiles are installed no higher than 11 feet above the floor, and space is available between the ceiling tiles and the structural floor above. Utility poles are used to drop telecommunications cables from the ceiling pathway.

Suspended ceiling supports should not support wiring, and that wiring should not lie directly on the ceiling tile. Cable tray systems should be used above removable ceiling tiles in open office spaces. Cable tray systems are rigid, prefabricated structures that support telecommunications cables and wiring.

Open, ventilated cable trays are recommended for ceiling distribution systems. Trays should be installed as close as practicable above the ceiling tile, and have adequate support to withstand the stress of pulling the cables. Cable trays should be installed to meet the requirements of the National Electrical Code and local building codes.

Each 80 square feet of work area requires one square inch of cross sectional tray area. A minimum of 12 inches should be maintained above the cable tray for access.

Cable should be distributed according to a zone system. Typical zone systems divide the usable floor area into zones of 400 to 900 square feet. Bundles of horizontal distribution cable run from the telecommunications closet to the midpoint of each zone, and distribute to the work areas from that point.

Figure 5 shows a typical ceiling distribution system. Specifications for ceiling distribution systems appear in Section 4.6 of the Commercial Building Standard.

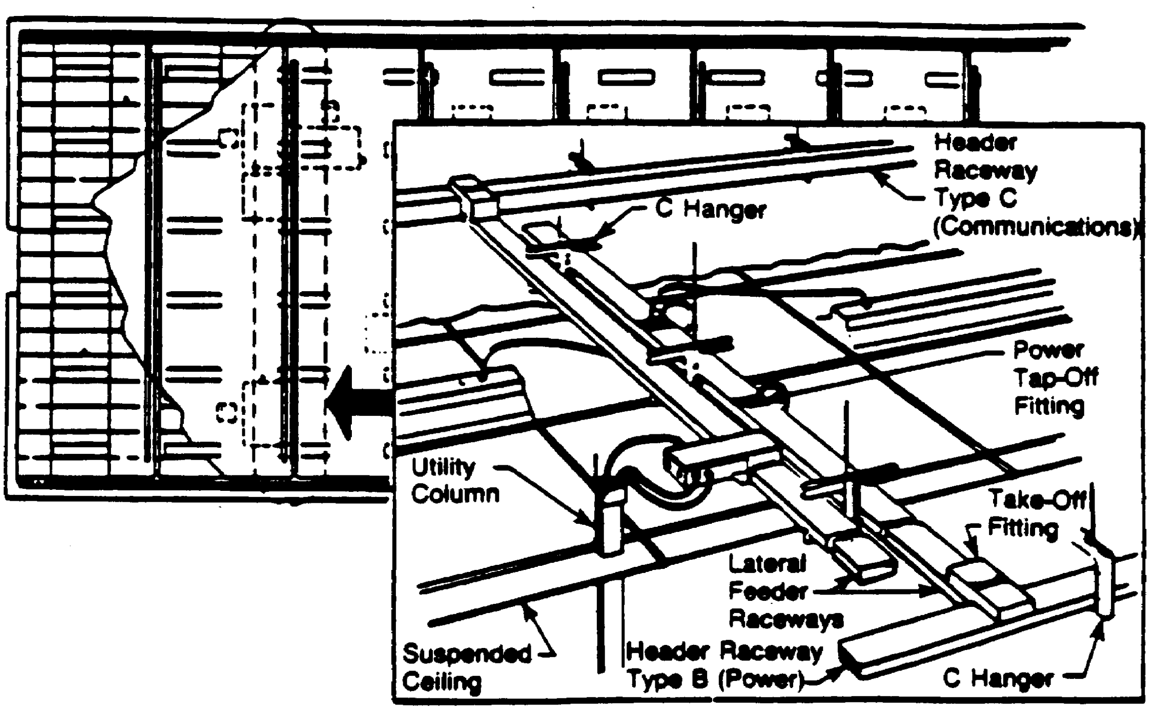
Hallway Cable Trays

Hallway cable trays, closed and attached to the wall, are the preferred horizontal pathway configuration to serve individual enclosed offices. Cable trays should be placed on the wall anywhere from floor to ceiling height; baseboard placement is prevalent.

For general office space, one square inch of cross-sectional area in the tray is required for each 80 square feet of usable floor space. Specifications for cable tray systems appear in Section 4.5 of the Commercial Building Standard.

Ceiling Distribution Pathway

Figure 5



1.2 Backbone Pathways

The backbone of the telecommunications network carries the heaviest traffic. Within a building, the backbone is often called the riser system, the facilities that connect equipment rooms, telecommunications closets, and entrance facilities. Intrabuilding backbones may require both vertical and horizontal pathways (Figure 1). In a campus environment, the backbone includes the connections between buildings (Figure 6).

Standards for Backbone Pathways:

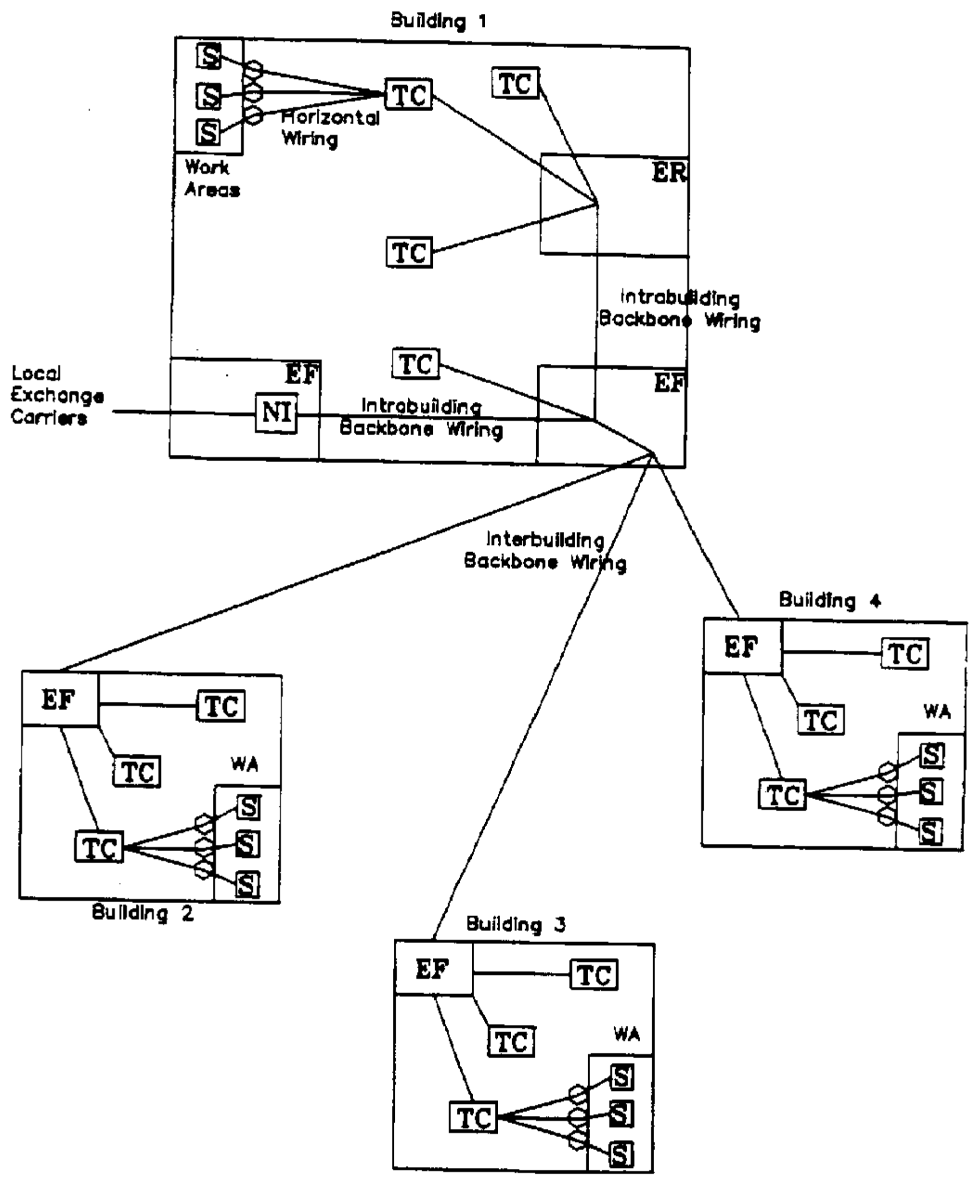
- One riser pathway for each 10,000 square feet of floor space
- Vertically aligned closets form intrabuilding pathways
- Minimum of one active and two spare sleeves per telecommunications closet per floor
- Underground interbuilding pathway

Campus Backbone

Figure 6

Legend:

TC	Telecommunications Closet
ER	Equipment Room
WA	Work Area
EF	Entrance Facilities
NI	Network Interface
⬡	Telecommunications Outlet
S	Station Equipment



Intrabuilding Pathways

The intrabuilding backbone is formed by stacking telecommunications closets on top of one another and creating cable pathways between them. The backbone facility should be logically located within its serving area, usually adjacent to the building core.

The pathway consists of shafts, conduits, raceways, and sleeves which provide routing space for the backbone cables. Backbone pathways shall be capable of supporting multiple media types.

A backbone pathway shall extend from the closet facility to the entrance facility, by way of a cable tray dedicated for this function. Backbone pathways shall also extend to the building roof.

For design purposes, one vertical backbone facility is required for each 10,000 square feet of usable floor space. At a minimum, three (one active and two spare) four inch conduits or sleeves shall be available to serve each telecommunications closet for each floor in a multistory building. Sleeves should be four inches in diameters. Smaller sleeves do not cost less or save a significant amount of space, and may unnecessarily limit the backbone capacity.

Vertically aligned closets with connecting sleeves or slots are the most common type of backbone pathway. Vertically aligned closets allow access to the backbone cable sheath on each floor, and circuits can be distributed as required. Cables sleeves should be positioned near a door and adjacent to a wall supporting the backbone cables. Sleeves must not obstruct terminating equipment.

All sleeves and slots shall be constructed to conform with local fire codes. Sleeves will extend a minimum of one inch above floor level, and be threaded for fire stopping caps. Slots will include a minimum one inch high curb.

Firestopping

Firestopping is required for each end of all backbone pathways. Firestopping is the installation of special materials into openings in fire-rated barriers (usually floors, ceilings, or walls) to re-establish the integrity of the barrier. Firestopping for ceiling openings is especially critical.

The firestopping requirement generally applies to any building construction or renovation. Detailed firestopping requirements are set by the National Electrical Code and local building codes.

Interbuilding Pathways

Interbuilding pathways link multiple buildings for local area (or campus) telecommunications. The star wiring topology recommended for the media and specific distance limitations recommended for each type of media may influence interbuilding pathway design.

When utility tunnels exist between buildings, they provide the preferred route for interbuilding telecommunications pathways. Underground conduits may also be used for interbuilding pathways. While not as flexible as tunnels, underground conduits preserve the aesthetic appearance of the building, are adaptable for future media replacement, and physically protect cable. Underground conduits have a high initial installation cost and require careful route planning.

In a campus environment four-inch conduit should extend from the building entrance facility through the exterior for interbuilding connectivity. These conduits should be designed in accordance with the Commercial Building Standard pathway design specifications.

1.3 Telecommunications Closets

A telecommunications closet is a local telecommunications equipment room. The space provides a secure environment for the installation of cable, telecommunications equipment, and termination and administration systems. Telecommunications closets are the point where the backbone and horizontal distribution facilities intersect. They are floor-serving rooms which terminate and connect the backbone cable system to the horizontal cable system and house electronics that distribute information to a floor.

The telecommunications closet should be located near the center of the area served, preferably in the building core area. When a floor requires multiple closets, the closets shall be vertically aligned from floor to floor relative to the space served.

Standards for Closet Spaces:

- One closet for each 10,000 square feet of floor space
- Vertically aligned closets and sleeves
- Continuous climate control
- Closet size based on size of area served

Closet Contents

Closets contain wiring terminations and telecommunications equipment to serve a floor. This equipment may include modular fiber distribution panels, termination cross connects, alarm systems, multiplexers, key telephone systems, paging systems, LAN file servers, multiple station access units, concentrators, bridges, community antenna television (CATV) equipment, and equipment racks. A telephone must be installed in each telecommunications closet.

Quantity

One telecommunications closet is the standard for each 10,000 square feet or less of office space. Closets serving modest-sized areas keep cables runs under 150 feet.

Closet Size

In new state office construction or space leased for ten years or longer, telecommunications closets shall be sized in accordance with the Commercial Building Standard to support the area served:

Minimum Serving Area (square feet)	Closet Size (feet)
10,000	10 x 11
8,000	9 x 10
5,000	7 x 10

The recommended minimum ceiling height is eight feet, six inches. A design layout for a typical telecommunications closet is included as Figure 7.

Closets should be designed with adequate conduit or openings through beams and other obstructions into the accessible ceiling space. False ceilings should not be installed in telecommunications closets.

Typical Telecommunications Closet Layouts

Figure 7

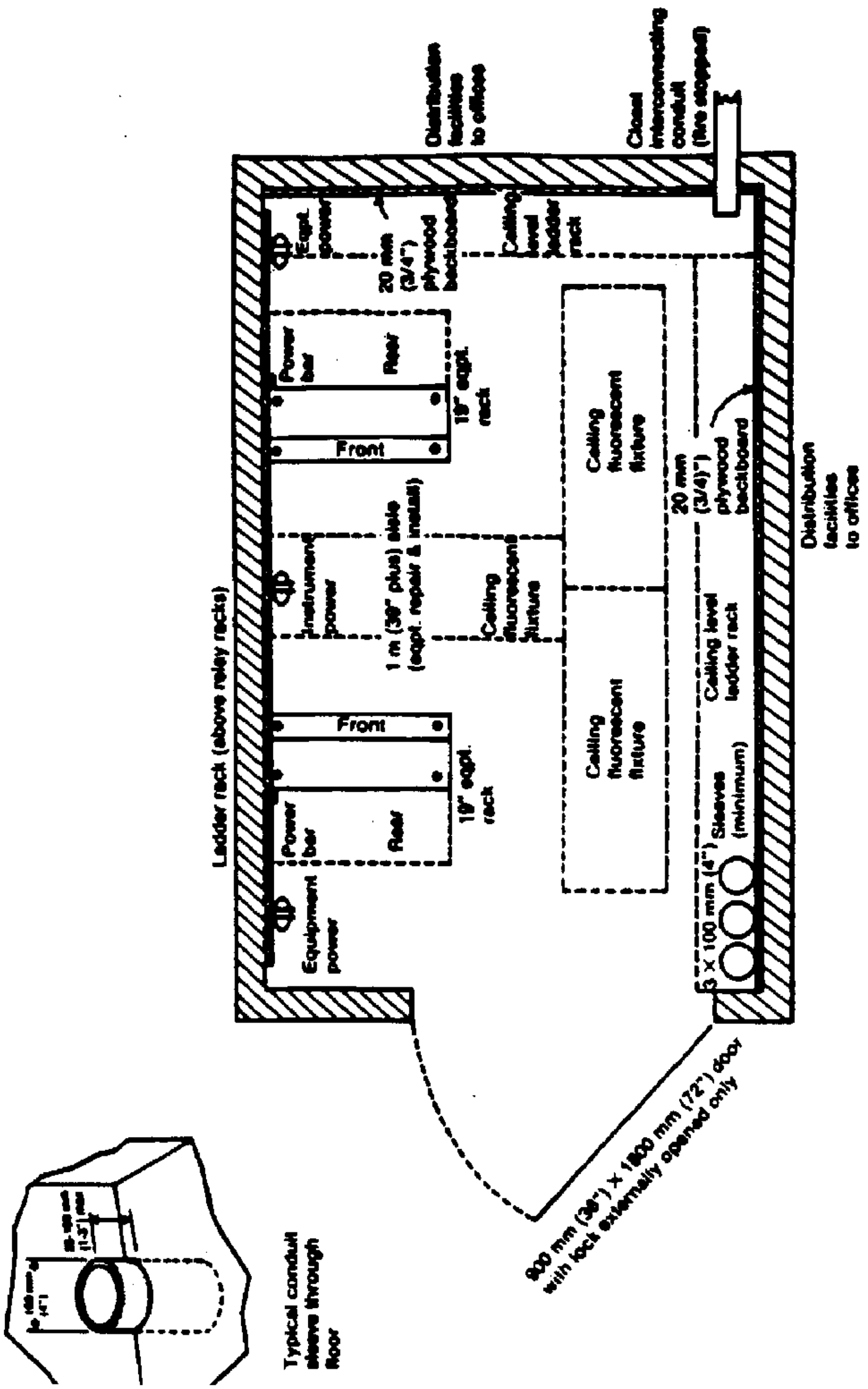


Diagram of a Large Apparatus Closet

The diagram below shows a large apparatus closet.

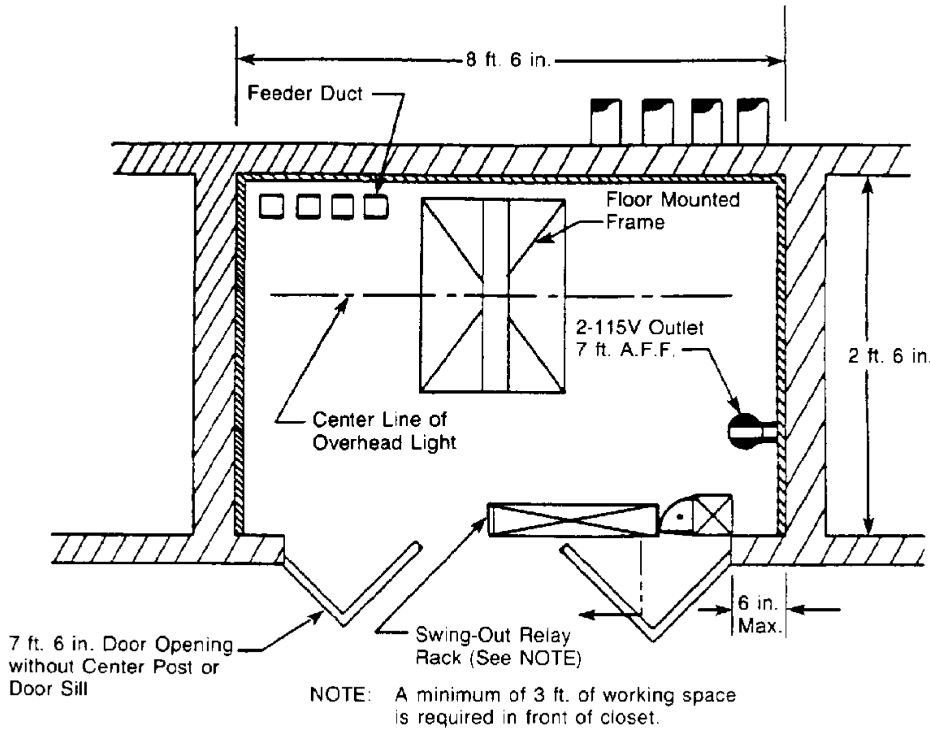
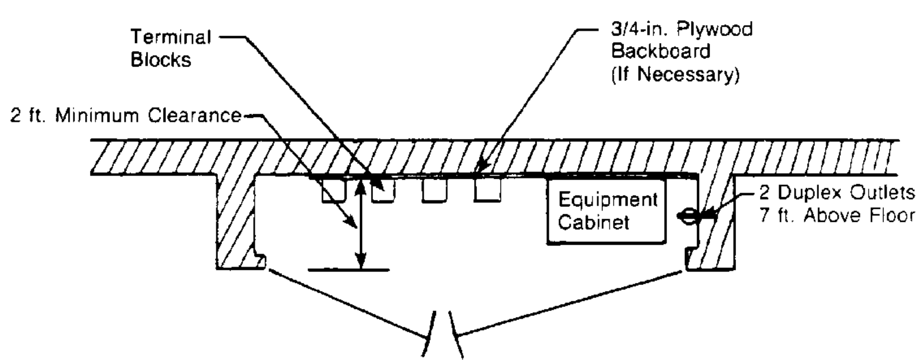


Diagram of a Shallow Apparatus Closet

The diagram below shows a shallow apparatus closet.



Environment

Telecommunications closets require continuous climate control. Air conditioning must maintain temperatures in the range of 65 to 75 degrees Fahrenheit, with relative humidity in the range of 40 to 55 per cent.

Since telecommunications systems work continuously, environmental control equipment must function properly at all times. If the building system cannot assure continuous operation, a stand-alone unit with independent controls for the telecommunications closet may be necessary.

Installation of tile instead of carpet and sealed concrete floors in closets will protect equipment from dust and static electricity.

Power and Lighting

Installation of a 50 amp 20 position subpanel, dedicated to telecommunications equipment only, is recommended. Separate power should be installed if a stand alone climate control system is installed in the closet.

Installation of an uninterruptable power supply system should be considered to support LAN server operation.

Closets should be equipped with a minimum equivalent of 50 foot-candles of light measured three feet above the floor level. Light fixtures should be located below cable trays, but at least eight feet six inches above the floor.

Backboards

The backboards used in telecommunications closets shall be three-quarter inch plywood treated with fire retardant.

Collocation of Electrical Components

It is the state standard that major components of the building electrical system not be collocated in the telecommunications closet. Telecommunications closet space shall be dedicated to the telecommunications function. Only electrical installations supporting telecommunications systems shall be located in the telecommunications closet.

Security

Unique locks are recommended. Applicable building codes provide specific fire protection recommendations.

1.4 Equipment Rooms

Equipment rooms house large scale equipment, such as mainframe computers and centralized telecommunications switching equipment. Pathways connecting to the backbone and entrance facilities are required.

The equipment room should not be used as staff office space. Many network administration activities may be appropriately assigned to general office space.

Equipment rooms typically require 12 inch raised flooring. Room size, floor loading, security, and power will depend on planned uses. For design purposes, 200 square feet should be considered a minimum size.

Environment

Telecommunications equipment rooms normally require a controlled climate environment. Air conditioning should maintain temperatures in the range of 65 to 75 degrees Fahrenheit, with relative humidity in the range of 30 to 55 per cent.

Since telecommunications usually function on a continuous basis, environmental control equipment must work properly at all times. If the building system cannot assure continuous operation, a stand-alone unit with independent controls for the equipment room may be necessary.

1.5 Entrance Facilities

The entrance facility serves the entire building. It connects the intrabuilding and interbuilding backbone components and often contains electronics to serve all areas of the building. Interbuilding connections might include local telephone company access circuits, state-owned interbuilding LAN connections, interexchange carrier access circuits, a community antenna television access, and a central system for various alarm circuits.

It is desirable to locate the network interface at the main cross-connect.

Demarcation

Since the Federal Communications Commission deregulation of inside wire, the telephone company's responsibility for installation and maintenance of telecommunications wiring ends at the point where their wire connects to a building or campus wiring facility. This cross connect takes place at a demarcation strip (demarc) designated as the electro-regulatory boundary.

The demarcation point divides the telephone company from the service subscriber. Everything on the company side of the boundary is owned by the company and leased to customers as part of a service. Identifying the location of the boundary is a critical step in the management of the wiring resource. Only telephone company employees are allowed to work on wiring or equipment on their side of the demarc boundary. Customer personnel may work on wiring on subscriber's side of the boundary.

Location Standard

At this time, the Washington Utilities and Transportation Commission (WUTC) has not approved rules to specify the location of the demarc in new construction. The Commission intends to establish the boundary at a location mutually acceptable to the building owner and the telephone company.

It is the state standard that in all new construction, the demarc shall be located inside a building in a designated telecommunications entrance facility or equipment room. Any difficulties encountered in negotiating demarc locations with a regulated local telephone company shall be reported to the Utilities Division of the WUTC, (360) 753-6423.

Specifications

The Commercial Building Standard contains detailed specifications for the entrance room space, the entrance point, and the service entrance pathway, including: underground duct or conduit, direct buried cables, and aerial cables. These specifications shall be incorporated in state office design.

Four-inch conduits shall extend from the building exterior wall to allow access to the public network. In a campus environment, additional conduits should be installed for inter-building connectivity.

Security

Unique locks are recommended for all telecommunications entrance facilities. Keys should be available on site during working hours. Outside access is not recommended.

1.6 Grounding and Bonding Guidelines

The increasing need for the reliable transfer of massive amounts of information creates an environment in which electrical protection takes highest priority. The primary consideration in developing requirements for grounding, bonding, and electrical protection is safeguarding personnel, property, and equipment from potential harm from foreign electrical voltages and currents.

The electrical protection of telecommunications facilities is an essential part of any distribution system. The National Electric Code (NEC) defines grounding and bonding parameters for telecommunications from the perspective of human safety. NEC Articles 250 and 800 cover the general requirements for grounding, bonding, and protecting electrical and telecommunications circuits.

It is the state standard that telecommunications systems be isolated to the building ground. NEC does not specify grounding and bonding parameters from the performance aspect. Neutral ground current problems are so severe in some modern buildings that the telecommunications systems fail to work, even though the grounding complies with NEC requirements. In some state offices, more stringent requirements may be needed to ensure adequate electrical protection for telecommunications and computing equipment. In addition to the NEC requirements, the grounding instructions and requirements of the equipment manufacturer should be followed.

In 1989, a new EIA standards effort was initiated to create a standard for the grounding and bonding of commercial buildings. The standard will define uniform grounding for all components of the building grounding system that directly or indirectly affect telecommunications. This grounding system will support a multi-product, multi-vendor environment. The intent of the standard is to minimize performance problems. When it is published, the EIA Standard for Grounding and Bonding of Commercial Buildings will be incorporated into this document.

2. Building Wiring

Building wiring consists of the cables that make telephones, image and data devices communicate across a room, or across the state. Building wiring includes horizontal distribution facilities, cross connection equipment, and backbone facilities.

2.1 Horizontal Wiring

Horizontal wiring distributes wiring between the information outlet in a work area and the telecommunications closet (Figure 8).

Standards for Horizontal Wiring:

- Two cables of 4-pair, unshielded twisted pair (total of 16 wires)
- Star topology
- Maximum cable length of 295 feet

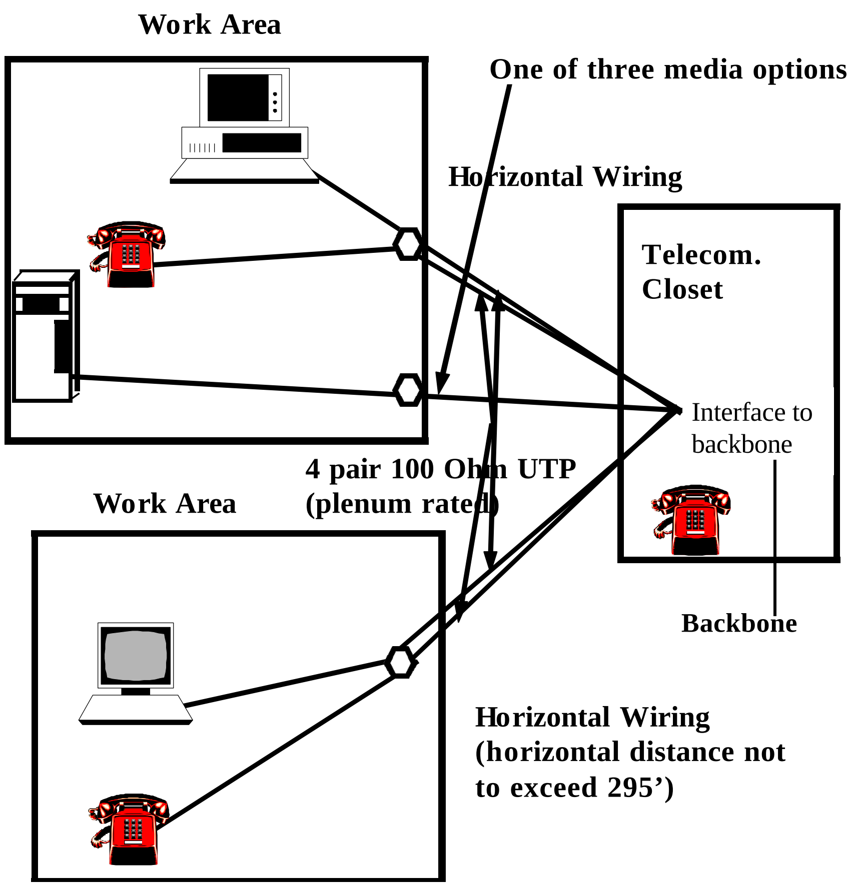
The standards define a uniform wiring system to support a multiproduct, multivendor environment.

Topology Standard

Every information outlet shall be connected to a telecommunications closet in a star topology, as specified in the Commercial Building Wiring Standard.

Horizontal Wiring

Figure 8



Star topology is also sometimes described as "home run" or "radial" topology. Current implementations of 802.3 Ethernet bus and 802.5 token ring systems have been designed to handle star wiring through concentrators or multiport devices.

Distance Limitations

The maximum cable length from closet to outlet is 90 meters or 295 feet, as specified in the Commercial Building Wiring Standard.

Media Standard

In new state office construction and newly leased facilities with a term of five years or more, the minimum standard for horizontal distribution wiring is two cables of four pair, 24 gauge unshielded twisted pair (UTP) wiring to each work area.

UTP wiring consists of two insulated wires twisted around each other to reduce induction, thus interference, from one wire to the other. Twisted pair wire comes in bundles with varying numbers of pairs of wires. "Four pairs" means four sets of twisted pair wires enclosed in the cable sheath. The standard specifies 100-ohms impedance at one megahertz, satisfying Integrated Services Digital Network (ISDN) and IEEE 802.3 (1Base5 and 10BaseT) requirements.

Plenum cable shall be used in all building horizontal distribution systems, even when the spaces are not used for air delivery systems. This wiring shall meet or exceed the cable specifications in Section 10 of the Commercial Building Cabling Standard (Appendix A).

Four pairs are recommended for lower performance telecommunications applications, such as switched telephone service and ISDN applications. The remaining four pairs shall be dedicated to higher performance telecommunications applications, such as LANs operating in the range of 10 million bits per second (Mbps) and higher. All cable shall be tested by the installer for compliance with the specifications in Appendix A.

Additional Media

In addition to the minimum quantities of unshielded twisted pair specified in this standard, supplemental media may be installed to support agency telecommunications applications. These include: fiber optics, shielded twisted pair, additional unshielded twisted pair and coaxial cable.

Fiber Optics:

> Optical fiber cable consists of thin strands of transparent and translucent glass or plastic through which light is transmitted. The light source for multi-mode optical fiber is usually a light emitting diode (LED). Fiber optics have a much greater bandwidth (information carrying capacity) than twisted pair cable.
>
> Optical fiber may be used in the horizontal wiring system for specific applications or environmental requirements. These applications might include planned deployment of high-data-rate, fiber based systems such as the 100 Mbps Fiber Distributed Data Interface (FDDI).
>
> Four strands of 62.5/125 micron, graded-index, multi-mode optical fiber cable are recommended for future use as horizontal media. The core of the recommended fiber has a recommended diameter of 62.5 microns (or micrometers), and a cladding diameter of 125 microns. This cable shall meet or exceed the specifications of the Commercial Building Cabling Standard

and meet FDDI ANSI standard X3T9.5 requirements for 100 Mbps transmission.

Fiber cables should be terminated with ST-type II connectors, a small, high performance, installer friendly connector for single fiber connections. Use of an FDDI to ST connector coupling makes the outlet compatible with FDDI plugs.

Detailed specifications for the recommended media are included in Appendix A. All fiber optic cables shall be tested at the time of installation for compliance with the specifications in Appendix A.

Shielded Twisted Pair

Two pair 150 Ohm shielded twisted pair (STP) cable (commonly called type 1 cable) is used for some data processing equipment. The shielding improves electromagnetic radiation and susceptibility performance.

Care should be taken to observe the manufacturer's cable shielding grounding requirements.

Unshielded Twisted Pair

Additional quantities of the media standard 4-pair UTP plenum cable may be installed to satisfy application demands.

Coax

Coaxial cable may be installed to support CATV and/or other full-motion video applications.

2.2 Intrabuilding Backbone Wiring

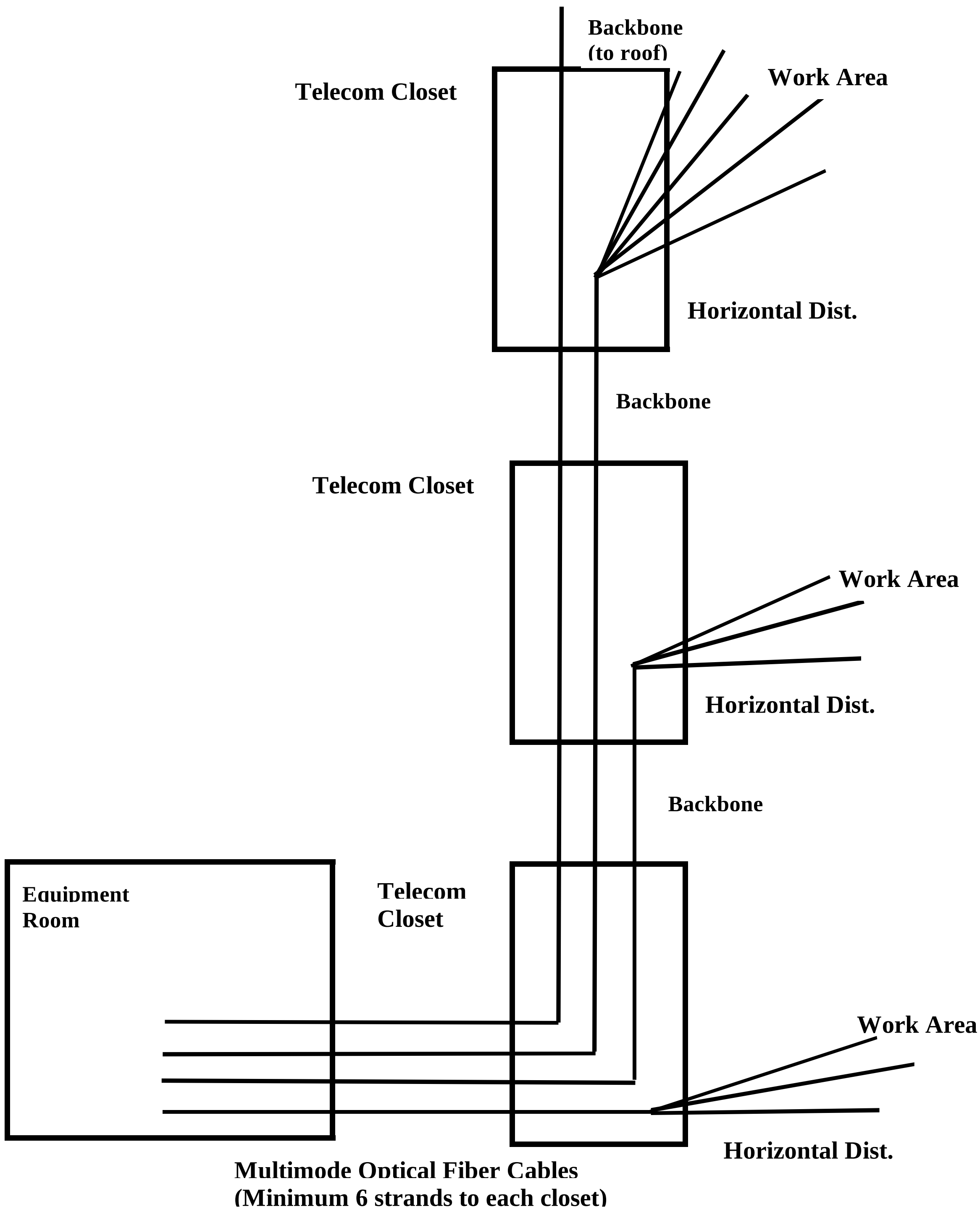
An intrabuilding backbone consists of the transmission media, cross-connects and terminations for interconnecting telecommunications closets, equipment rooms and network interfaces within a building (Figure 9).

Standards for Backbone Wiring:

- Optical fiber cable
- Unshielded twisted pair
- Star topology

Backbone Media

Figure 9



Topology Standard

The Commercial Building Wiring Standard specifies a star topology for backbone wiring, using a maximum of two levels of cross-connects (main and intermediate). Interconnection between two telecommunications closets shall pass through a maximum of three cross-connects (intermediate - main - intermediate). Reaching a main cross-connect shall not require passage through more than one cross-connect.

Media Standard - Fiber Optic s

Graded-index, multi-mode optical fiber cable is the media standard for the intrabuilding backbone. A minimum of six fiber strands shall be installed to serve each telecommunications closet. Additional quantities may be installed to support unique agency applications. This cable shall meet the specifications in Commercial Building Cabling Standard of Appendix A.

Testing is required as part of the backbone installation. The optical fiber backbone shall not be spliced during the installation.

Additional Media - Unshielded Twisted Pair

In addition to the media standard, 100 Ohm unshielded twisted pair may be used as the backbone media for some lower performance applications.

Distance Standards

A maximum distance of 1640 cable feet (500 meters) is the standard between a telecommunications closet and the intermediate cross-connect. The maximum recommended distance between a telecommunications closet and the main cross-connect is 6560 cable feet (2000 meters) for optical fiber, and 2625 cable feet (800 meters) for unshielded twisted pair.

Networks outside the bounds of the distance limits require partitioning into smaller areas, linked by wide area networks.

2.3 Interbuilding Backbone Wiring

A backbone wiring system consists of the transmission media, cross-connects and terminations for interconnecting telecommunications closets, equipment rooms and network interfaces. An interbuilding backbone is the same except it goes between buildings through an entrance facility. There are special considerations for building to building wiring due to environmental and distance specifications.

Standards for Backbone Wiring:

- Optical fiber cable
- Star topology

Topology

The standard specifies a star topology for backbones across a campus. The topology shall use a maximum of two levels of cross-connects (main and intermediate). Interconnection between two telecommunications closets shall pass through a maximum of three cross-connects (intermediate - main - intermediate). Reaching a main cross-connect shall not require passage through more than one cross-connect.

Media Standard

Graded-index, multi-mode optical fiber cable is required for the interbuilding backbone. This cable shall meet or exceed the specifications for fiber cable in the Commercial Building Cabling Standard.

Distance Limitations

With a fiber optic backbone, a maximum distance of 1640 feet is recommended between a telecommunications closet and the intermediate cross-connect. The maximum recommended distance between a telecommunications closet and the main cross-connect is 6560 feet.

2.4 Work Area Wiring

The work area is the location of telephones, personal computers, terminals, facsimile machines, or other telecommunications devices. This minimum standard assumes two telecommunications devices per work area, and one work area for each 80 square feet of usable floor space. To obtain maximum building flexibility, all potential work areas shall be pre-wired.

Standards for work area wiring:

- 8-Pin modular jacks

Information Outlet Standard

Information outlet specifications define the connections for the jacks and terminators used in the horizontal media. A single dual jack information outlet shall be installed for each work area location. This is a minimum standard. Some applications may require installation of additional media and additional jacks.

Each four-pair cable shall be terminated in an eight-position modular jack at the work area. Any special keying requirements are to be handled outside the jack with connectors. Outlets dedicated to high performance telecommunications applications should be identified with color coding or labels.

Nonpermanent Wiring

Wiring from the work area equipment to an information outlet is not permanent. Because of the changeable nature of work area wiring, the Commercial Building Cabling Standard does not address it.

The length of this station wire should not exceed ten feet (three meters). It must have the same performance and electrical characteristics as the horizontal wiring, including connectors and adapters used to connect work area devices to the information outlet.

2.5 Telecommunications Closet Wiring

The telecommunications closet connects the intrabuilding backbone to the horizontal wiring. It can contain cross connects, terminations and active or passive equipment to support telecommunications services.

Standards for Closet Wiring:

- Passive front terminations for UTP
- High density devices

UTP Cross Connect Terminations

Requirements for the termination blocks used in the closet for making backbone and horizontal UTP cable connections include:

passive front
gas tight connections
highest possible density to conserve space
easy to use and administer

Technical specifications and testing procedures for this equipment appear in the Commercial Building Cabling Standard. Patch-cord cross connect hardware is recommended for unshielded twisted pair wiring.

When adding to or remodeling closets, Underwriters Laboratory listed, passive front devices, with gas tight connections should replace existing termination blocks.

Fiber Cross Connect Devices

All backbone fiber cables shall be terminated with permanently installed rematable connectors. The maximum optical attenuation for each mated connector pair shall not exceed 0.7 dB.

Technical specifications for this equipment are included in the Commercial Building Cabling Standard.

Termination of optical fiber cables shall be the current version of ST-type connectors enclosed in termination panels with sufficient size and capacity to terminate 120% of the combined fiber count of the backbone and horizontal cables. ST-type connectors are twistlock, bayonet mounts with straight ferules.

2.6 Equipment Room Wiring

The equipment room houses major components of large telecommunications systems such as PBXs, data switches and communications processors. Equipment rooms differ from telecommunications closets in the size and quantity of the equipment they contain. Generally, only connections to backbone cable are made in the equipment room.

Terminations

The termination blocks used in the equipment room shall be the same cross connect system specified for telecommunications closets. High-voltage circuit protection shall be provided for cables leaving a building.

2.7 Entrance Facilities Wiring

Entrance facilities house interbuilding connections, including local telephone company access circuits, state-owned interbuilding LAN connections, interexchange carrier access circuits, community antenna television access, and a central system for alarm circuits.

It is desirable to locate the network interface at the main cross-connect. Federal Communications Commission Rules Part 68 defines requirements for connection of equipment to the public telephone network.

3. Infrastructure Administration

Federal deregulation of the telecommunications industry changed the administration of the telephone wires inside buildings. Deregulation transferred responsibility for administering building wiring to building owners. Upon deregulation, existing documentation concerning the function and location of wires often did not reach the building owner which created problems in controlling the building cable plant.

In late 1989, a new EIA standards effort was initiated. The goal of the Telecommunications Administration Standard is to establish standards for:

- Wiring (horizontal, backbone, etc.)
- Terminations (blocks, connectors, etc.)
- Building pathways (trays, ducts, etc.)
- Building spaces (closets, entrance facilities, etc.)

Administration includes component labeling, paper documentation, and data base documentation. The state of Washington subscribes to the national standards, which will outline the basic principles of administration of telecommunications distribution and wiring systems. The following sections include specific requirements for state offices.

3.1 Hardware

Arrangement of patch panels, equipment racks, and punch down blocks should allow natural wiring progression and easy access to each component. This promotes easy testing and moves, adds and changes and minimizes crossing of wires.

Color coding

All connecting hardware should be color coded to allow tracking of the originating and terminating points of a group of wire pairs. The national standard calls for the following color codes:

Green	Network interface leads from the telephone company or other telecommunications carriers.
Purple	Leads from common switching equipment ports.
Yellow	Leads from auxiliary equipment (such as dial-up modems).
White	Leads from the equipment room to backbone telecommunications wiring closets or between primary telecommunications closets.
Blue	Leads from closets to work area information outlets.
Gray	Leads between primary and secondary or satellite closets.
Orange	Leads from point to point multiplexers.
Red	Leads from special services such as alarms and hazardous voltages.
Brown	Interbuilding backbone leads.

Cross Connect Hardware

Even if only one end of the cross connection is affected by a change, patch cords should be completely removed and reinstalled. This reduces cord entanglement and promotes a neat appearance. Termination equipment for high performance telecommunications applications should be clearly identified.

3.2 Documentation

Numbering Plans

The Commercial Building Wiring Standard recommends labeling each work area with a unique identifying number. The standard describes this number as eight to ten alphanumeric characters, including references to the building and the floor of the building where the work area is located, the telecommunications closet serving the work area, and three digits identifying the work area itself. For example, an identifying number like **OB04102C** would refer to a location in a state office building (**OB**) on the fourth floor (**04**) in work area number **102** wired from telecommunications closet **C**.

At the telecommunications closet, the number that identifies the work area relates to a position on the punch down blocks or patch panels. Each position on a punch down block or port on a patch panel also has a unique number. For example, **Block 5, Position 4** identifies a unique location in a given closet that a work area connects to, and **A-08** identifies a specific patch panel port.

Cable Labeling

All cables and wires shall be permanently, legibly labeled. The cables that run from the telecommunications closet to the work area information outlet shall have a unique identifying label within two inches of the connector in the work area, and within two feet of the cable end in the closet.

All connectorized fiber cables shall be labeled within two inches of the connector.

Each work area information outlet shall be labeled.

All backbone cables shall be labeled on both ends with an identifying number that carries with them from the telecommunications closets to the equipment room or entrance facility.

Record Keeping

Record keeping is the key to efficient moves, adds, and changes. According to Commercial Building Wiring Standard: "Maintaining records and documents are the most important parts of the administration." The IBM Cabling System Planning and Installation Guide states, "It is **extremely important** to keep records of the cables installed in your building. At a minimum these records should provide enough information to allow you to find each end of a cable drop. You should set up a cable record system and print the cable identification labels **before** you install a cabling system" (emphasis in the original).

Manual record keeping for building wiring is paper intensive. While paper records are sufficient to maintain an inventory for smaller offices, an automated system is recommended for larger, information intensive facilities. This allows telecommunications or facility managers to document and trace components of telecommunications systems within and between buildings. The components traced include cables, cable pathways, connectors, jacks, adapters, wiring closets, distribution frames and other termination equipment, panels, cross connects, and ports.

An inventory should also include building spaces, entrance facilities, backbones and telecommunications closets. These records need to be updated each time a move, addition, or change occurs.

Space and Pathways

An inventory of space and pathways shall include identification numbers and utilization information for both vertical and horizontal facilities.

Entrance Facilities

Entrance facility records shall include an inventory (number and quantity) of telephone company demarcation connecting blocks, the entrance cable type and quantity, and the type of protection on the entrance cable.

Backbone

Backbone records shall include an inventory of all cable numbers with the quantity of pairs of wires, or strands of fiber. They shall also contain the closet identifiers and the location of the frames that are connected to each end of the cable. If the wires in one cable are dropped in more than one closet, or terminated on more than one frame, the break-up must be documented.

For fiber cable backbones, "as built" records (the installer's actual documentation, as opposed to the designer's plan) are valuable administrative and maintenance tools. The system route diagram prepared after installation should indicate:

- the cable route,
- the location and quantity of slack cable,
- cable route and meter marks at splice and termination points (an important tool for cable fault-location).

Backbone cable runs shall be tracked from the main distribution frame (entrance facility) through cross connect points, and linked by the horizontal distribution records to the work area information outlet.

Telecommunications Closets

Records for telecommunications closets shall include the quantity and type of cross connecting equipment, the quantity and type of cabling, and basic information about terminating equipment.

Horizontal Distribution Cables

An inventory of cable pairs (available and active), cable type, and cable numbers shall be maintained for horizontal distribution systems. As with the backbone, "as built" records and route diagrams shall be maintained for horizontal wiring as well.

Work Area

Work area records include jack identification, pin number information, and the work area identification number.

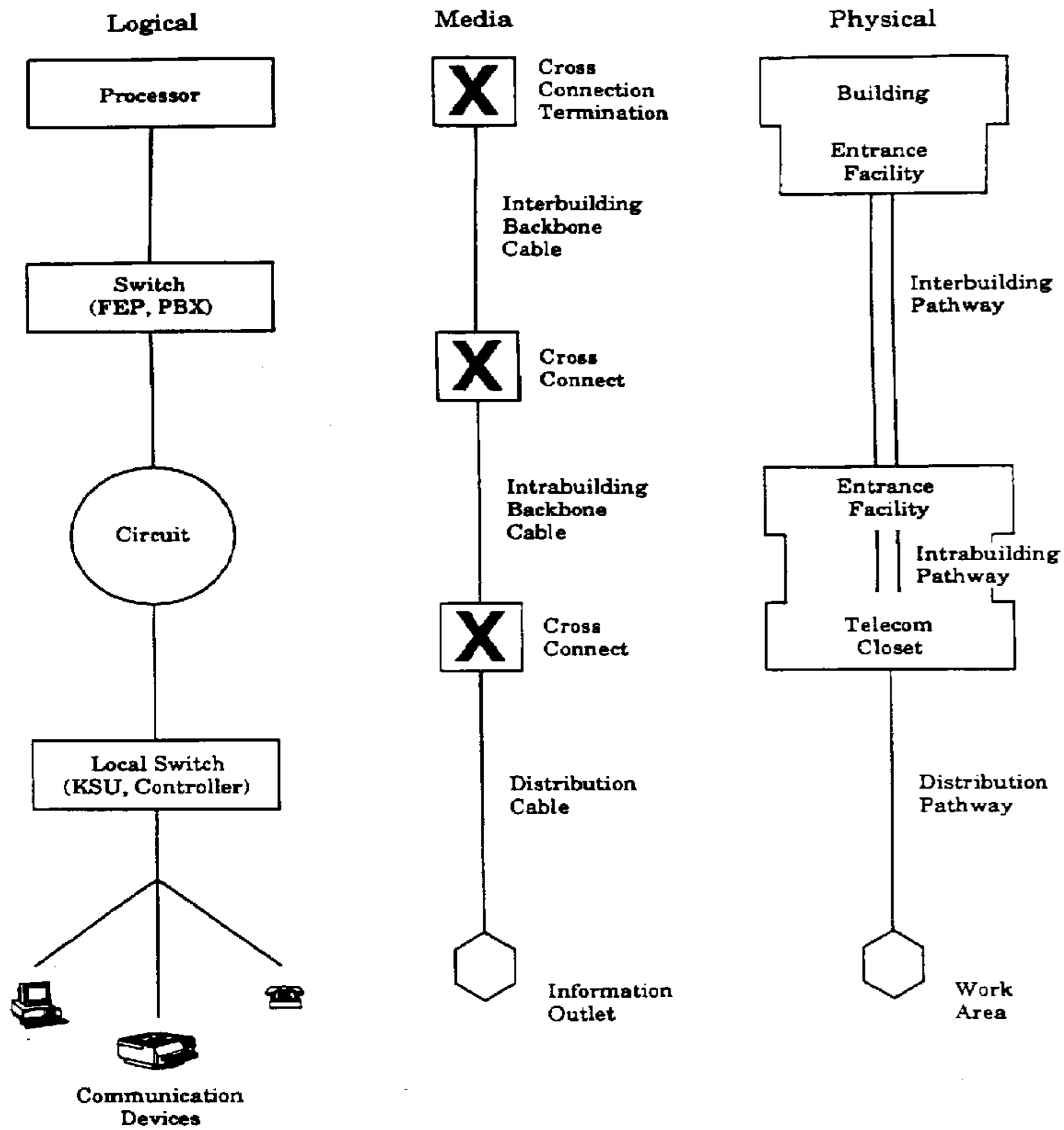
3.3 Organization

Telecommunications components consist of three partitions (Figure 10): logical components (devices, circuits), media components (wiring, connections), and physical components (building pathways and spaces). Responsibility for administration of the logical components should be provided by a telecommunications switching center, data center, or alarm center. Telecommunications problem resolution requires that the service provider maintain an accurate inventory of these components.

Administration of the infrastructure components (media and physical) should be provided on a building (or campus) basis by the facility manager.

Complete documentation should be required for all infrastructure components as a condition of installation. Maintenance of the physical component documentation is the responsibility of the facility manager. Maintenance of the media component documentation is the responsibility of the tenant agency making a change.

Backbone Media
Figure 10



Appendix A

Excerpts from the Telecommunications Industries Association and the Electronic Industries Association Draft Commercial Building Cabling Standard

This appendix contains excerpts from the draft national standards promulgated by the Electronics Industries Association dated March 29, 1994. The following portions are included:

- Table of Contents
- Section 10, UTP Cabling System

Appendix B

Definitions

ANSI: American National Standards Institute, a leading U.S. standards setting organization.

Attenuation: The power loss in a wire or cable system, typically expressed in decibels (dB) per unit length.

AWG - American Wire Gage, a standard system for designating wire diameter.

Backbone - The part of the telecommunications network which carries the heaviest traffic. On a campus the backbone includes the wiring between buildings. In a building, the backbone consists of the cables that vertically link telecommunications closets ("riser" cables in multistory buildings).

Bps - Bits Per Second, a measure of transmission speed. Usually represented as Kbps for thousand (kilo) bits per second or Mbps for million (mega) bits per second.

Cable - An assembly of one or more electrical or optical conductors within an enveloping sheath, constructed to permit the use of the conductors singly or in groups.

Coaxial Cable - A solid piece of metal wire, surrounded by insulation, surrounded by tubular piece (or braid) of metal and a protective cover. Coaxial cable provides a much higher degree of protection against electrical interference than twisted pair wire.

Cross Connect - The link between two wiring systems; distribution equipment used to terminate and administer communications circuits.

Deregulation - The removal of government regulatory oversight from a business. In Washington it may also mean removal of regulatory oversight from a specific service provided by a company whose other activities are still regulated.

DTE - Data Terminal Equipment, the end user's equipment, typically a terminal or computer that can function as the source or destination for communication on a network.

EIA - Electronics Industries Association, an organization of U.S. manufacturers of electronics parts and equipment. The EIA develops standards for the interface between data processing and telecommunications equipment.

Entrance Facilities - The space in a building where the network interface is located. The transition between inside and outside cable plant occurs here. This is where the local telephone company's wiring connects to the customer's wiring backbone. Interbuilding connections for a campus would also be made here.

Equipment Room - An area that houses major components of large telecommunications systems (PBXs, data switches, communications processors). Equipment rooms are distinguished from telecommunications closets by the size and quantity of the equipment they contain.

FCC - Federal Communications Commission, an agency of the federal government established by the Communications Act of 1934. It regulates interstate (intrastate) communications originating in the United States. This includes telephone, radio frequency, and broadcasting activities. The FCC 1) Sets prices for interstate phone, data and video services; 2) Determines who can provide communications services; 3) Establishes the electrical and physical standards for communications equipment.

FDDI - Fiber Distributed Data Interface, a LAN technology that permits 100 Mbps data transfer. FDDI is proposed as ANSI standard X3T9.5.

Fiber - See optical fiber.

Horizontal Wiring - The distribution wiring between the information outlet in a work area and the telecommunications closet, where connections are made to the intrabuilding wiring backbone.

IEEE - The Institute of Electrical and Electronics Engineers, a professional organization that sets networking standards. For example, the IEEE 802 committee's standards deal with the physical and data link layers of the OSI protocols.

Information Outlet - The modular 8-pin jack installed in a work area to connect a communicating device with the horizontal wiring facility.

Intermediate Cross Connect - Typically the equipment used to link the backbone and horizontal wiring systems. The intermediate cross connect is usually located in a telecommunications closet.

ISDN - Integrated Services Digital Network. ISDN is designed to reduce the carriers' costs and overcome the perceived deficiencies in today's network in four ways: 1) provide an accepted international standard for data, voice, and signaling, 2) make all transmission circuits digital end-to-end, 3) adopt a standard out-of-band signaling system, and 4) bring more bandwidth from the carrier to the customer.

ISO - International Standards Organization, the promoter of the OSI model, an independent international body formed to define standards for multivendor network communications.

LAN - Local Area Network, a short distance network (typically within a building or campus) used to link together computers and peripheral devices under some form of standard control.

Kbps - Thousands of bits per second.

Main Cross Connect - Typically the equipment used to link the interbuilding and intrabuilding wiring systems. The main cross connect is usually located in the building entrance facility.

Mbps - Millions of bits per second.

Media - The substance or material used to carry the data in a transmission. This is usually a copper wire, but might be optical cable or a microwave transmission signal.
NEC - National Electrical Code.

Network Interface - The demarcation point where the telephone company's wiring connects to the subscriber's wiring.

Ohm - A unit of electrical resistance. One ampere flowing through a one ohm resistance produces a voltage drop of one volt.

Optical Fiber - Thin strands of transparent and translucent glass (or plastic) through which light is transmitted. The light source may be a laser or light emitting diode (LED). Cables made of optical fiber generally have a much greater bandwidth (information carrying capacity) than either coaxial or twisted pair cable.

OSI - Open Systems Interconnection, a logical structure for network operations. The OSI structure has seven layers (application, presentation, session, transport, network, data link, and physical). Each layer depends on the services of the layer below it and provides services to the layer above.

Patch Cord - A length of wire, or fiber cable, with connectors on each end. A patch cord is used to join telecommunications circuits at a cross-connect.

PBX - Private Branch Exchange, a telecommunications switching device used within an organization for internal and external telephone traffic. A PBX switches calls among lines connecting telephones or terminals, tie lines, and trunks.

Server - A specialized computer that provides a particular service (such as file or print service) to a network.

Shielded Twisted Pair (STP) - Wiring consisting of two insulated solid copper wires twisted around one another and wrapped in a metallic shield. Shielding reduces electrical interference problems, but also reduces the strength of the signal transmitted.

Station Equipment - Telephones, terminals, PCs, facsimile machines, printers, and any other communicating equipment located in a work area.

Telecommunications - RCW 43.105.020 says "telecommunications means the transmission of information by wire, radio, optical cable, electromagnetic, or other means."

Telecommunications Closet - The space in a building which houses cable, telecommunications equipment, and termination and administration systems. Telecommunications closets are the point where the backbone and horizontal distribution facilities intersect. They are floor-serving rooms whose function is to terminate and connect the backbone cable system to the horizontal cable system and to house electronics that assist in the distribution of information to that floor.

Topology - The pattern of physical and logical links between nodes on a network.

Unshielded Twisted Pair (UTP) - Wiring consisting of two insulated wires twisted around each other to reduce induction, thus interference, from one wire to the other. Twisted pair wire comes in bundles with varying numbers of pairs of wires, from two pair (four wires) to many thousands of pairs. UTP wiring is used to wire telephone networks within buildings because it is inexpensive and relatively easy to install.

Work Area - The part of the building where telephones, personal computers, terminals, facsimile machines, or other telecommunications devices are located. This is typically a general office space, where state employees do their jobs.

Appendix C

Resources

AT&T Premises Distribution System (August 1987) AT&T Information Systems, Lincroft, New Jersey 07738

Building Standards for Communications Media and Systems (October 1988) by Emory A. Kramer, state of Washington, Department of Labor and Industries, Olympia, Washington 98504

Building Standards for Telecommunications Media and Systems (1988, 1989 drafts), Electronic Industries Association (EIA) standards in review by EIA TR-41.8.3 Working Group, Washington, D.C.

Cabling Standards for Communications Media and Systems (October 1988) by Emory A. Kramer, state of Washington, Department of Labor and Industries, Olympia, Washington 98504

Commercial Building Wiring Standard (1988, 1989 drafts), Electronic Industries Association (EIA), Telecommunications Industry Association (TIA) standard in review by EIA Engineering Committee TR-41.8.1, Working Group on Commercial & Industrial Building Wiring Standard, Washington, D.C.

Communications Design Guidelines (January 1989 draft), University of Washington, Seattle, Washington 98195

Connection of Terminal Equipment to the Telephone Network, Rules and Regulations Part 68 (September 1987), Federal Communications Commission, Washington, D.C.

Guide to Premises Distribution (April 1988) by Robert K. Wright, AT&T Technical Publications, Lincroft, New Jersey 07738

Guidelines for Telecommunications (June 1989 draft), a paper by Jim Culp, State of Washington, Department of Information Services, Olympia, Washington 98504

Guidelines for Wiring/Re-Wiring DIS Buildings (1989) a paper by Jeff Sprehn, state of Washington, Department of Information Services, Olympia, Washington 98504

Handbook for Specifying, Selecting and Installing Local Area Networks and Universal Wiring Systems (Includes excerpts of the 1986 draft wiring plan for the State of California), by the Professional Staff of Zatyko Associates and Daniel C. Zatyko, 202 Fashion Lane #115, Tustin, California 92680

IBM Cabling System Planning and Installation Guide (October 1987) IBM Corporation, Communication Products Information Development, Research Triangle Park, North Carolina 27709

IBM Cabling System Technical Interface Specification (October 1987) IBM Corporation, Communication Products Information Development, Research Triangle Park, North Carolina 27709

Installation Specifications for Data Communications Cabling, paper by state of Washington, Department of Licensing, Olympia, Washington 98504

Logical and Detailed Network Design Report for Spokane Community Colleges (Three Volumes, January 1990) by Jack Hymer, Hewlett-Packard, Bellevue, Washington 98006

Managing Cable and Wire (September 1986), A seminar workbook by Jay F. Helms, Helms and Associates Consulting Engineers, 353 Bel Marin Keys Blvd. Suite 6, Novato, California 94947

Next Generation Network Architectures (February 1990), A seminar workbook by Dr. John M. McQuillan, McQuillan Consulting, Cambridge, Massachusetts

SYSTIMAX Premises Distribution System Administration Manual (1990) AT&T Technical Publications, Middletown, New Jersey 07748

SYSTIMAX Premises Distribution System Component Guide (1989) AT&T, Lincroft, New Jersey 07738

Telecommunications Distribution Methods Manual (1989), Building Industry Consulting Service International, GTE TestMark Laboratories, 3050 Harrodsburg Road, Lexington, Kentucky 40503

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Telecommunications Planning for Building Architecture and Wiring Systems (1989), a seminar workbook by Washington State University, Pullman, Washington 99164

Telecommunications Regulatory Monitor (1989), edited by David A. Irwin, Phillips Publishing Inc., Potomac, Maryland 20854

Voice and Data Communications Criteria (November 1989), from the General Requirements for the Natural Resources Agency Building, by the Telecommunications Services Division, state of Washington, Department of Information Services, Olympia, Washington 98504

Washington State Department of Transportation Voice/Data Cabling Standards (February 1990) paper by the state of Washington, Department of Transportation, Olympia, Washington 98504

WCCCC Network Planning and Design, Fiber Optic Cable Specification, a paper by the Washington Community College Computing Consortium, Redmond, Washington 98052
WCCCC Network Planning and Design, Twisted Pair Cable Specification, a paper by the Washington Community College Computing Consortium, Redmond, Washington 98052

Wiring and Physical Plant Guidelines, Methods, and Standards (1989) prepared for NASA Kennedy Space Center by Zatyko Associates, 202 Fashion Lane #115, Tustin, California 92680

WSU Exceptions to the EIA-569 Commercial Building Standard for Telecommunications Pathways & Spaces (May 1990) Washington State University, Pullman, Washington 99164

Appendix D

Horizontal Distribution System Selection Considerations For Open Office Space

Introduction

This appendix summarizes the principal considerations in selecting a horizontal distribution system for telecommunications media for new buildings and major renovations. These guidelines address only the telecommunications related considerations involved in the selection of the pathway; other factors, such as air handling, heating and cooling, lighting and electrical power distribution also have a significant effect on the ultimate decision. The analysis demands a total building design assessment. For this reason, it is not feasible to provide a complete "decision tree" based solely on telecommunications considerations.

The state standard approves two principal horizontal pathway methods for open office environments:

- Access floors
- Ceiling distribution

Factors affecting the choice between these are discussed below together with some overall comparisons and cost trends.

General Industry Trends

Perhaps the most comprehensive comparative assessment of the various horizontal pathway alternatives appears in an article published in Architectural Technology by Gary Hall, Vice President of Hammell, Green, and Abrahamson, an architectural and engineering firm in Minneapolis. In addition, USG Interiors and Tate Access Floors, major suppliers of various horizontal pathway systems, provided information which substantiated the conclusions of Hammell, Green, and Abrahamson. The experts note the following industry trends:

- Access floor is the most prevalent method for providing horizontal pathways in new office building construction. Approximately 50% of new buildings incorporate access floors in the design.

- When relocation costs are considered, all systems except the underfloor duct are close enough in price to leave room for analysis based on considerations other than cost.

- Access floor is becoming an industry standard for new office buildings with open space where frequent redesign is likely.

Key Factors

The choice of horizontal pathway depends on a number of issues, some of which extend beyond telecommunications considerations. As a guideline in the decision process, the following key factors should be assessed:

- Open Space vs. Fixed Office - Industry experience generally shows that the fixed office concept, where there is a lower likelihood of extensive moves, is most economically served by some form of ceiling distribution system.

- Rate of Change - A significant factor in the choice of horizontal pathway is the expected rate of moves, adds and changes. The higher the rate, the more favorable access floor becomes since the cost per change for the reconfiguration of telecommunications and the associated electrical power is significantly less than for other methods. As a general guideline, rates of change in excess of 20% per year tend to favor the access floor concept. In addition to the lower cost of moving electrical and telecommunications facilities, the access floor incurs the lowest interior space design cost since there are virtually no constraints regarding the relocation of outlets.

- Building Lifetime - Since the cost of moves, adds and changes becomes comparable to the initial installation cost for buildings with a long (greater than 20 year) lifetime, the longer lifetime buildings tend to favor the access floor arrangement. While telecommunications media itself probably has a lifetime on the order of ten years, the available pathways should have a lifetime commensurate with the building; the economics should be based on building lifetime.

- Aesthetics - The use of ceiling access with power poles in open space planning may be aesthetically displeasing for some applications. Ceiling distribution using columns in lieu of power poles, poses significant constraints on the floor plan layout due to the modular partitions used for wiring distribution from columns to the work areas. While there is no specific cost associated with this item, it is a qualitative consideration which needs to be assessed.

- Intended Use - The intended use of the facility affects the choice of horizontal pathway. General office space with significant use of personal computers, facsimile machines, local area networks, and associated devices experience a higher cost of moves, adds, and changes than an environment populated principally by persons requiring only a telephone and limited other office equipment.

- Time Required For Change - The need to make changes quickly bears on the selection of a horizontal distribution system. Access floors require the least amount of time for planning, obtaining the requisite contractor(s), and implementing the change. Access floor changes can be made in minutes or hours while ceiling and underfloor duct systems require work orders and weeks or months for completion.

- Changing Density of Occupancy - State buildings are subject to increasing personnel densities. The cost to add outlets is significantly less with the access floor approach. Cost trade-offs must also be made relative to pre-wiring to the maximum expected density or to the initial density. Installing wiring on a phased approach costs less with access floor systems. If the building is fully pre-wired then increasing densities create no problem.

- Other Functions - Ancillary functions, such as alarms and energy management systems influence choice of systems. High rates of change in these functions favor the access floor approach.

- Non-telecommunications Functions - The choice of horizontal pathway also depends on the economics of such factors as heating and cooling, desired ceiling height and electrical distribution. Typical ceiling heights are nine feet. Many organizations trade off an 8.5 foot ceiling height to allow access floors without increased building height.

Cost Comparisons

The building life cycle cost per square foot figures for access floor and ceiling distribution rely on the following assumptions:

	Initial Costs	Cost Per Move
Access Floor	$7.25 per sq. ft.	$80
Ceiling Distribution	$4.50 per sq. ft.	$200

The difference in cost per move will increase due to inflation as these costs are highly labor intensive. For example, using 5% annual inflation:

Cost Per Move

	Year 1	Year 5	Year 10
Access floor	$ 80	$ 97	$124
Ceiling	$200	$255	$325

The cost for 300 moves, adds and changes per year, for years 1, 5 and 10 would be:

Access floor	$24,000	$29,000	$37,000
Ceiling	$60,000	$76,000	$97,000